# DOCUMENT RESUME

ED 145 832 IR 005 256


AUTHOR Lindqvist, Mats

TITLE Timeliness of Information Provided by SDI, Retrospective Search, and Original Source.

INSTITUTION Royal Inst. of Tech., Stockholm (Sweden). Library.


REPORT NO TRITA-LIB-4021
PUB DATE Jun 73
NOTE 45p.

EDRS PRICE MF-$0.83 HC-$2.06 Plus Postage.
DESCRIPTORS Data Bases; *Information Dissemination; *Information Networks; *Information Storage; *Libraries; On Line Systems; Systems Analysis; *Systems Approach
IDENTIFIERS Retrospective Search Services; Selective Dissemination of Information



ABSTRACT

After discussing the nature of timeliness and its importance to the user of information systems, this document examines the factors which affect timeliness in three subsystems of the scientific communication system. The first subsystem moves a document from the existence of new knowledge to the point of entry into an information system; the second takes it from point of entry to completed registration in searchable files; and the third involves the process of searching and dissemination. Factors which affect the first subsystem include verification lag, manuscript writing, refereeing and editing. The second and third subsystems are examined in terms of three types of information systems: Retrospective Search Services (RSS), Selective Dissemination of Information (SDI), and Libraries. (WBC)



**********
* Documents acquired by ERIC include many informal unpublished *
* materials not available from other sources. ERIC makes every effort *
* to obtain the best copy available. Nevertheless, items of marginal *
* reproducibility are often encountered and this affects the quality *
* of the microfiche and hardcopy reproductions ERIC makes available *
* via the ERIC Document Reproduction Service (EDRS). EDRS is not *
* responsible for the quality of the original document. Reproductions *
* supplied by EDRS are the best that can be made from the original. *
**********

ED145832

REPORT TRITA-LIB-4021 JUNE 1973

U S DEPARTMENT OF HEALTH, EDUCATION & WELFARE
NATIONAL INSTITUTE OF EDUCATION

THIS DOCUMENT HAS BEEN REPRODUCED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL NATIONAL INSTITUTE OF EDUCATION POSITION OR POLICY

# TIMELINESS OF INFORMATION PROVIDED BY SDI, RETROSPECTIVE SEARCH, AND ORIGINAL SOURCE

Mats Lindqvist

Royal Institute of Technology Library
S-100 44 STOCKHOLM 70

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY

Stephan Schwarz

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC) AND USERS OF THE ERIC SYSTEM."

IR005252

{Published in K. Samuelson et al.: *Evaluation of Information Retrieval Systems and Functions*, NORDFORSK, Stockholm 1974}

# TIMELINESS OF INFORMATION PROVIDED BY SDI, RETROSPECTIVE SEARCH, AND ORIGINAL SOURCE

## INTRODUCTION

In order to be meaningful an information system must be a part of a bigger system. The information is collected, processed, and distributed for some reason. For instance, Management Information Systems are designed to give management better grounds for decisions by presenting information that is aggregated, condensed and displayed in a way preferred by some decision makers.

In a similar way an information system for scientific and technical information serves society by the dissemination of such information from one sub-society to another (sub-society being anything from an individual to a nation). The role of these information systems for the technological development has been the object for many studies.

From a high level view the main function of an information system (in the sense given above) is to relay knowledge.

Accepting this as a starting point we state that we are interested in the information system from the time new knowledge exists to the time it is consumed by a knowledge generating system, the output of which is new knowledge.

The study is, however, limited to knowledge that has been documented in one way or another, i.e. recored knowledge. This limitation does not imply that we consider non-recored knowledge unimportant - the constraint is purely practically motivated.

## SOME ASPECTS OF TIMELINESS

### Timeliness as a goal parameter

In general terms, objectives of an information system are to provide the right amount of information in the right form at the right time (Hjerppe, Lindqvist, 1971). The goal component "right amount" is sometimes stated as "the wanted" or "the required" or "the relevant information". We let "right amount" stand for a qualitative property as well as a quantitative similar to what is implicit in (Langefors, 1973, p.159) i.e. what could be called "the right information" in a more general sense.

Timeliness, then, as a systems parameter is mainly related to the goal component "at the right time" and timeliness itself can be broken down into lower level systems parameters.

The fact that information systems are part of many supersystems that often are of socio-economic or socio-technical character does, however, complicate the picture. What is "the right information" also becomes a function of time and consequently there is a "timeliness" aspect on this goal component as well. Furthermore if we consider the possibility (or fact) that users of the information system learn more about both the subject matter in question and information usage techniques as time goes by there is also a timeliness aspect of "the right form".

To sum up the discussion: Timeliness is a high level system parameter that is directly related to the goal component "at the right time". Environmental characteristics makes it hard completely to isolate timeliness from other systems parameters, especially the high level parameter "serviceability".

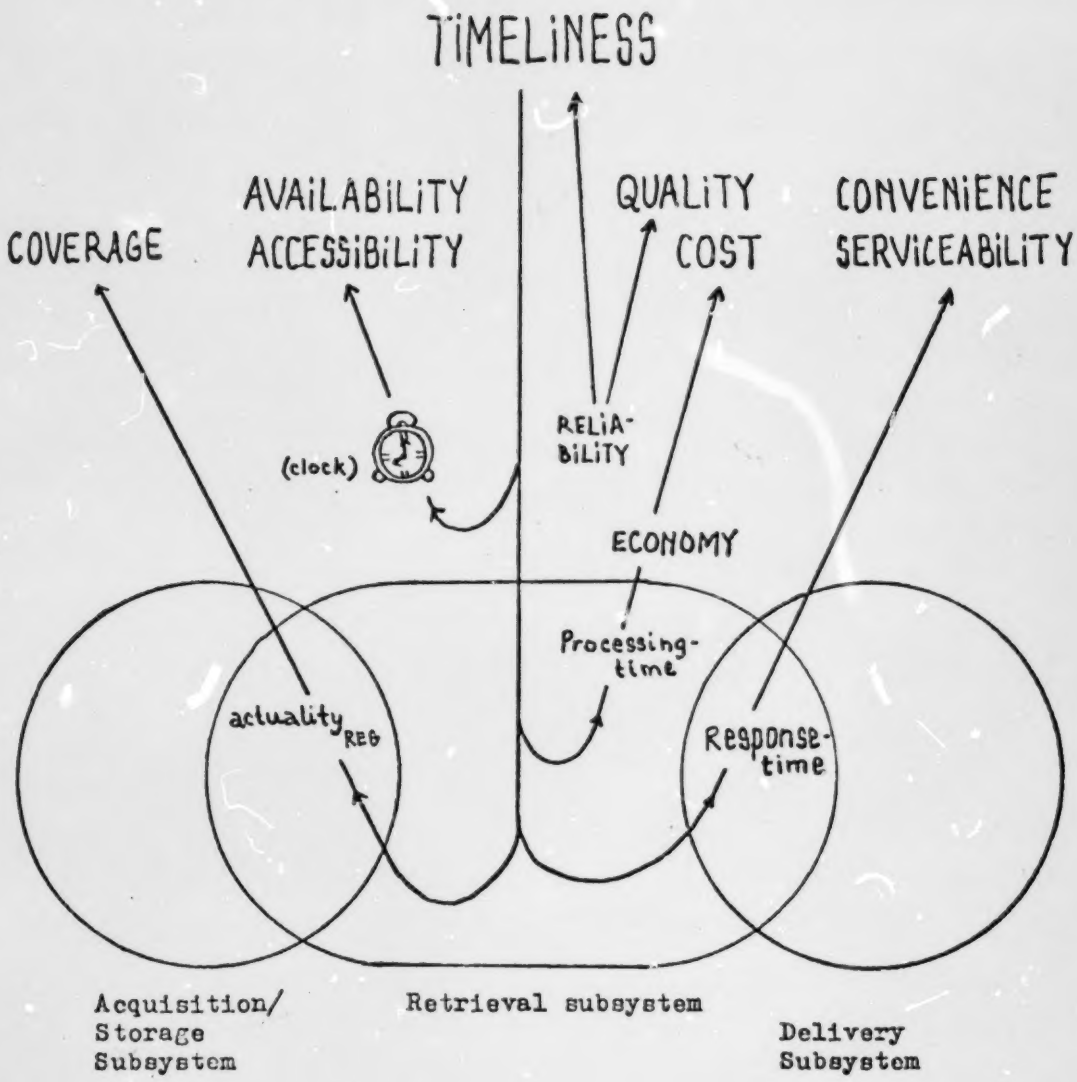



Figure 9.

The principal interconnections between timeliness and other high level systems characteristics.

Time and Timeliness

To make possible a more analytical discussion on timeliness it might be appropriate to make some observations on its essence: time. With his special theory of relativity Albert Einstein rejected the view of time beeing something absolute: a continous time-flow from an infinitive past to an infinitive future (Barnett, 1960).

Time is something subjective: it is a way of describing events relative to each other: That is to say that "before", "at the same time as", and "after" are the only true time measurements. Compare e.g. Langefors' precedence, incidence and succedence relations. Similarly "sometimes", "often", and "seldom" are probability statements about (repeated) descriptions of the relation of events; here we have a coupling between timeliness and reliability.

Man's aversion to such imprecise metrics brought invention of the "clock" long before Einstein's theory. Recognizing the relativity of time a "clock" can be described as a thing which provides us with a series of events that are countable. This means that we can describe time-points as well as time-spans.

For our purpose we do not have to worry about the relativity of time, but it is important that we recognize that timeliness refers to both time-points (e.g. before p.m. local time) and time-spans (e.g. response time of 5 seconds).

In order to carry out systems analysis there is a fundamental dualism about time that must be clarified. This dualism can be illustrated by two phrases:

a) "you cannot turn the clock back" and b) "time is money". To explain this further: On one hand time is a continuum (had it not been for Einstein we could have said "something absolute"), on the other it is a resource that can be traded off with other resources such as money, space or knowledge. In the following we shall use the terms "clock time" and "process time" respectively when we need make this distinction.

## Time factors in Systems Analysis

Let us regard a system with a given goal structure for a defined period of time. A suitable period (= a span of "clock time") would be one cycle in a cyclic system. For example in the case of most operating information systems in the sense described in this study operations would run during the daytime and at night the system would be idle (with possible exception of maintenance) we can talk of a 24-hours cycle, and thus a day would be an appropriate study period.

Inside the system it is possible to run several operations in parallel to gain "clock time". In figure 10 a sample system is shown where it could be possible to achieve a faster turn-around and earlier delivery by speeding up one of the processes (pr 2).

With a system like one in figure 11 the situation is more complicated: processes are dependant on completion of other processes and it is difficult to decide which processes to speed up in order to get the best effect (on turn-around) for the cost of speeding up. This is partly a "scheduling problem" and there are optimal solutions for certain situations.

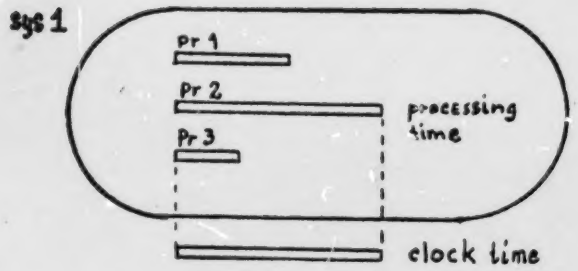



Figure 10

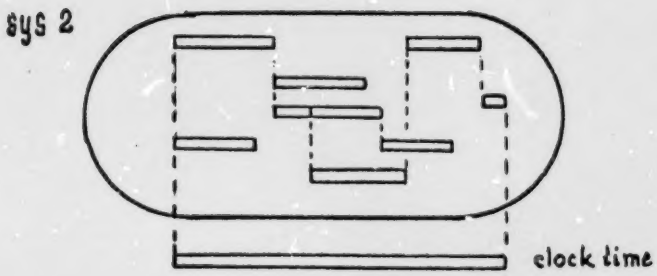



Figure 11

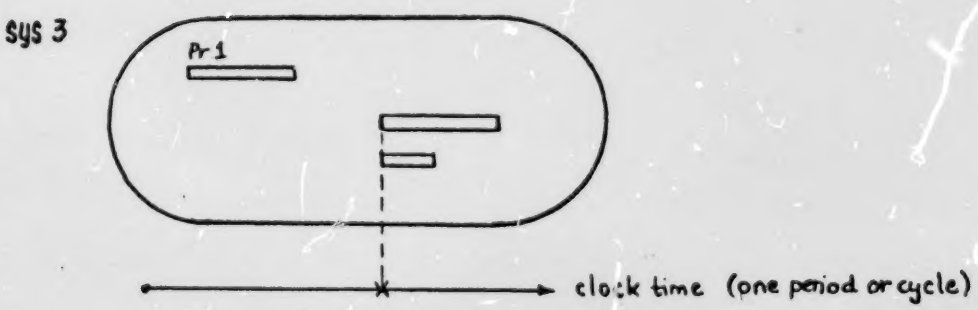



Figure 12

As the complexity of a system grows the occurence of idle time in various processes increases. To a degree these gaps are disadvantageous since they represent an opportunity cost (the equipment could have been used for other operations). Mostly, however, it is not desirable to eliminate these gaps even if it were possible; certain gaps are necessary to obtain satisfactory reliability of the system - making corrections takes time too.

The two sample systems discussed above are, of course, over simplified and we shall try to make our models more realistic.

So far we have only looked at the "clock time" in terms of time spans - it is necessary also to study time points. Systems that exist in a real life situation have many couplings between internal "processing time" and "clock time" like the one illustrated in figure 12. The interpretation of this coupling is that an operation is waiting for the proper "clock time" before it is initiated. There are essentially two types of couplings: the operation may be time-triggered (e.g. starts at 8 a.m.) or event-triggered (e.g. starts when a customer enters the office). These couplings may also be interdependant (e.g. the customer cannot get into the office before 8 a.m.).

By speeding up process 1 in sys 3 it is possible to achieve shorter turn-around but not earlier delivery (still an improvement since one can accept later orders).

With the systems in figure 10 and 11 the systems designer has the possibility to avoid gaps in the "clock time" - there is no unnecessary waiting time for the customer. With systems like the one in figure 12 it is likely that there will be such gaps. These waiting times are unnecessary in the sense that it is technically possible to avoid them e.g. by paying overtime charges.

Timeliness and Speed

As stated earlier timeliness means "at the right time" and it is well worth pointing out that this is not identical with "as fast as possible". For one thing couplings to "clock time" makes it unrealistic to try a straightforward minimization of the time delay in the system; what good would it do to have the output ready by 9 p.m. instead of 11 p.m. if the customer is off work from 4 p.m. and unreachable?

Furthermore in a complex system (of socio-economic or sccio-technical character) too high a speed might be dangerous since errors that enter the system are propagated quickly and might lead to unfortunate events before there is a chance of taking any corrective action. In this connection it should be noted that an error can follow the regular path through the system which is relatively fast in an integrated system. The corrective actions, on the other hand, are usually management-by-exception type processes and these are normally slower than the system's integrated processes.

Bagdikian (1971) gives some good examples regarding the speed of information in a chapter called "How good is fast?".

In the case of human processes (individuals) delays for improved reliability will occur in a natural, intuitive way. McDonough (1963, p.268) calls this "verification-lag" and states: "Because of a human desire to be right, individuals may hold back information until they have enough confidence in the facts presented to them. ... The particular information may be withheld until its validity can be tested or until circumstances force it to be distributed without testing." In some cases this delay is observable, but mostly it is not.

## THE SCIENTIFIC COMMUNICATION SYSTEM

The scientific and technical communication system comprises a large number of different objects (documents, men, machines) and interconnected subsystems with many parallel and by-pass couplings. Maintaining the high-level partitioning introduced in Figure 9 with three subsystems (Figure 13) we can discuss some of the characteristics that are relevant to "timeliness".

Within the acquisition system we have to deal with a multitude of channells and media that all have different timeliness characteristics: books, journals, preprints, reports, proceedings etc. We also have to deal with more profane channels like the postal service.

The retrieval system can be of different types: Retrospective search service, SDI-service or library. For these various types, different aspects must be laid on timeliness.

The delivery subsystem, finally, may also include different media and channels.

We stated earlier that we were interested in the dissemination of knowledge from the time new knowledge exists to the time it is entered in a new knowledge generation process (i.e. it is "consumed"); we therefore will study the bordering systems that produce the input and absorb the output respectively, although not in any detail.

In studying timeliness we can take one of two approaches: We can study the way of one document (or "knowledge set") from producer to user (Figure 14) or we can follow the way of one query (Figure 15).

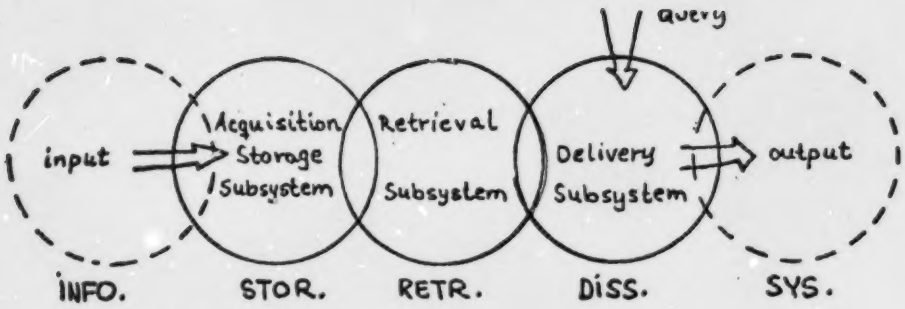
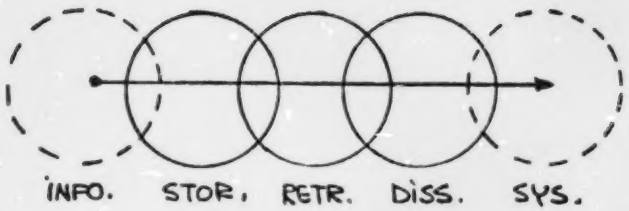
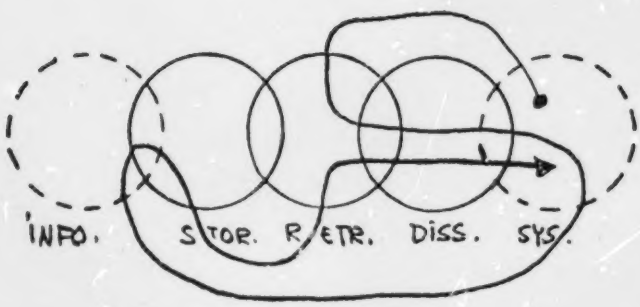



Figure 13




Approach 1:
Follow document

Figure 14




Approach 2:
Follow query

Figure 15

Although the alternative "follow query" is more complicated it gives so much more content to a discussion of timeliness. The reason, of course, is that timeliness as it is felt by the user is of paramount importance for his evaluation of the system.

In this study we shall use both approaches, but before continuing we shall introduce the concept of "actuality". We use the concept as it is intuitively understood: a measure of freshness. We make a distinction between "actuality$_{IN}$" and "actuality$_{USE}$" as is shown in Figure 16.

For the user two actuality-measures are of interest: How new is the searchable information in the system (which we denote "actuality$_{REG}$") and what is the actuality of the output to me, i.e. when I get it ("actuality$_{USE}$"). Since the time delays in the acquisition/storage system are different in different types of systems we need to use "actuality$_{IN}$" as a help-concept for the discussion.

In the below text we shall follow the document-way from existence of new knowledge to the point it is entering an information system. Then we discuss the delays between entry into system and completed registration (entry) in the searchable file for different types of systems.

Thereafter we shall follow the query-way through the search and dissemination systems. Time delays in the first part (as reflected by "actuality$_{REG}$") will, of course, affect the final result by giving a comparatively lower "actuality$_{USE}$".

As a framework for the discussion we have chosen the model of the information flow that is given in the UNISIST study (UNESCO, 1971, p.26) - this model is given in Figure 17 and we shall restrict our discussion to those parts that are heavy lined (own) in the figure.

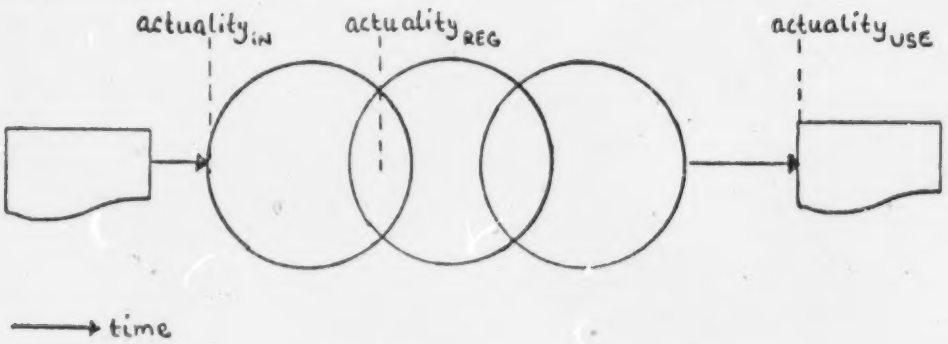



Figure 16

We shall divide "Information Centers" into "SDI-services" and "Retrospective search services" since these two types have different characteristics for timeliness.

In Figure 17 the most important couplings between different information systems are shown, but by no means all couplings. A user may have to go to several types of information systems (sometimes in loops, too) before his information need is satisfied. Furthermore existing information systems may be a compound of different types (to various degrees); most libraries, for example, have functions that can be classified as "retrospective search service" etc.

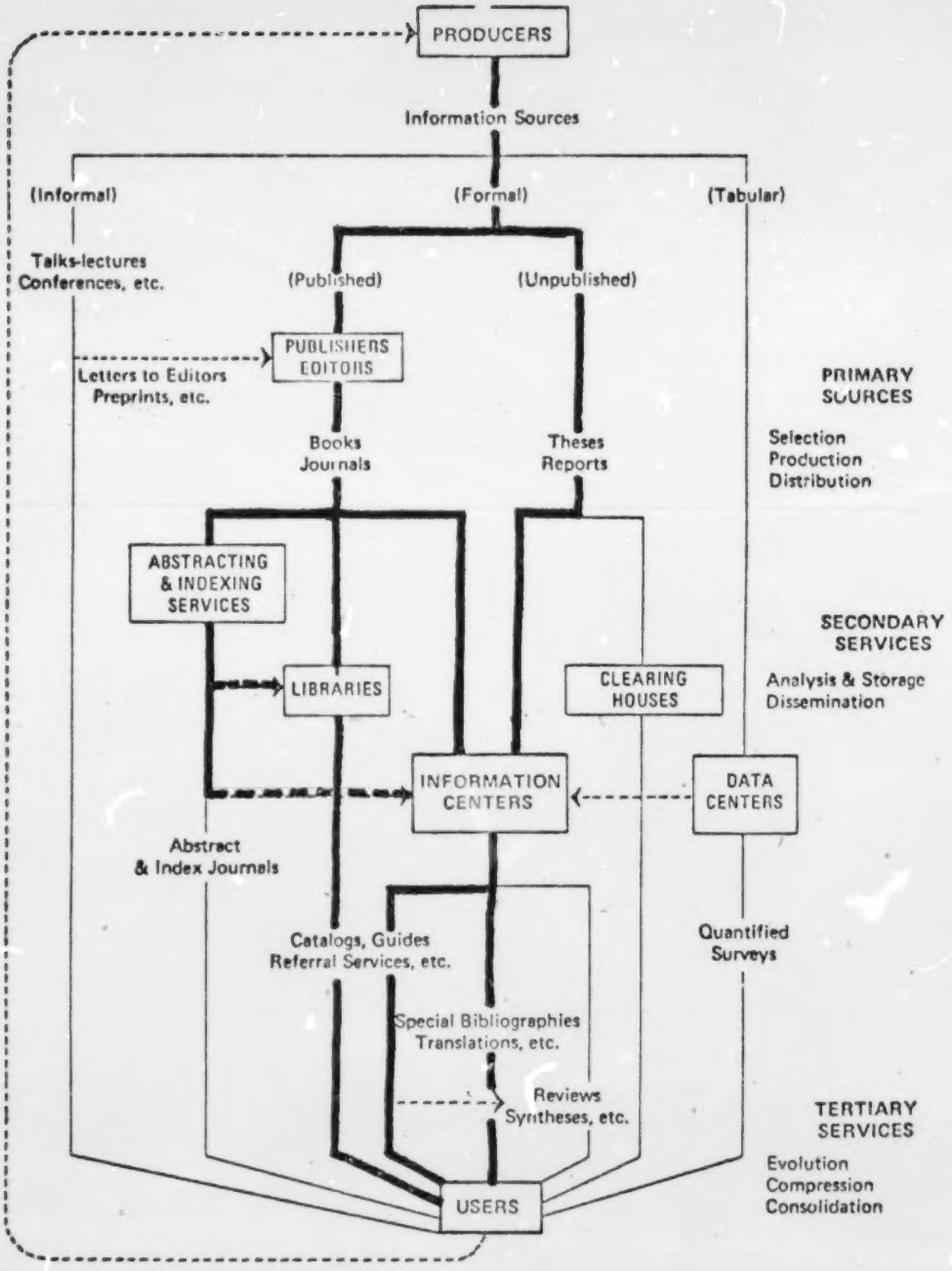



Figure 17.

The flow of scientific and technical information (after UNISIST).

## DOCUMENTS FROM ORIGIN TO SEARCHABLE FILE

### Document Production System

New knowledge in a large number of forms and the communication channels make up a complicated network. The network has been the object for an extensive study carried out by the Center for Research in Scientific Communication at the John Hopkins University (Garvey, et al., 1972); the reports from that project are recommended for those who want to study the subject matter of this section in greater detail.

The principal time components in the document production system can be illustrated in a rather simple way (Figure 18).

Verification lag. This factor is highly subjective and dependant on the nature of the particular experiment. In this situation the verification lag is neither observable nor controllable from our point of view. In most studies the earliest time factor to be studied is "from initiation of new work to reportable result" but these studies do not give any indication of the verification lag.

Manuscript writing time. Although not very big compared to other delays the effort in time required for writing manuscripts is often a critical factor since it takes time from the research and is, in some contexts, considered improductive. For this and other reasons the delay typically amounts to some months. A "normal" value would be 5 months. The development of good, general text-editing systems (Rice & VanDam, 1972) could improve the situation and make it easier to write and less time-

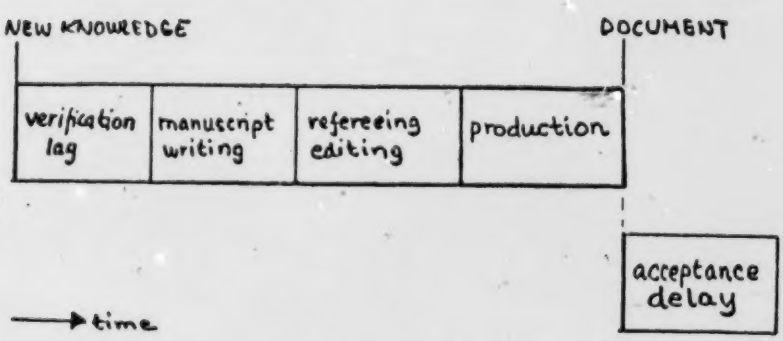

NEW KNOWLEDGE
DOCUMENT
verification lag
manuscript writing
refereeing editing
production
acceptance delay
time

Figure 18.

consuming. For yet some time a machine that accepts vocal input and produces written pages must be just wishful thinking.

Refereeing and editing time. The time delays connected with refereeing and editing have been given considerable attention and much criticism has been raised that the delay often is unnecessary long. A study in the field of agriculture (Jain & Goyal, 1969) gave as a result that the lag may be influenced by author's alterations, editorial board, criteria of priority, length and content of articles, cost of publication and printing facilities. The investigators found no correlation between time-lag and the bulk of paper.

In some fields, the refereeing is a bottleneck and it has been suggested that authors could make the circumstances easier by preparing their manuscripts better (which could be done by using text-editing systems) and refrain from sending a manuscript to more than one journal, thus tieing up fewer referees.

Submitted manuscripts are often sent back to the author for modifications which adds to the delay. Rejection of a manuscript, as found in the Johns Hopkins study (Garvey, et al., 1972) rarely prevents the manuscript's appearance in the public journal literature since authors try other journals. The time-lag is of cource increased by a rejection.

An alternative to the slow refereeing procedure is given by Sorokin (1969); a scheme where the articles were deposited at the journal office without refereeing and only the abstract published shortened the whole publication period down to 6 months. To ensure the

availability of the articles they were to be kept for 5 years.

The size of the time-lag refereeing and editing is anything from a few months to over a year. A "normal" value would be 9 months.

Production time. The technical work in printing a journal takes relatively little time and new techniques with automated typesetting has been developed for speedy printing processes.

The time to distribute the documents can to an extent be considered part of the production process since by tradition a paper is not considered to be "out" until it is on the news-stand (or equivalent). This, however, is true only for a defined geographical area (e.g. a nation) - subscribers in other areas must add "extra mailing time". It is customary that the publications date (which is a coupling between "clock time" and "process time") is set so that it will allow time for distribution in the defined area. We shall discuss the publication date further (below).

For the distribution there are, and will be more so in the future, alternatives to physical distribution by mail that are much faster: electronical transmission and printing in many locations, with the ultimate decentralization of printing (or displaying) on the user's personal terminal or other output device.

Acceptance delay. Since we are interested in following a document, we must consider the possibility that a document may be stopped temporarily by "environmental inertia". This delay is implicity discussed in works on science theory as to the causes. Citation studies show that some

documents are "lost" for a while and then rediscovered. Although this factor is somewhat on the side of this study it is not completely irrelevant since we are interested in evaluating the dissemination of knowledge.

It has been argued (Grossman, 1969) that librarians must "expand their conscious responsibilities so that they can react to crucial social needs" i.e. shorten this delay.

Actuality of Output from Document Production System

The study by Garvey and Griffith (Garvey; et al, 1972) gives some empirical results from the fields of psychology - these results are on the whole consistent with results presented in a study edited by deReuck & Knight (1967).

All times are relative "initiation of work", work was completed after 15-16 months.

- Journal 30 months
- Annual convention 21 months
- Technical reports 24 months

This actuality is "actuality$_{USE}$" when the user gets his information from original source, and it is "actuality$_{IN}$" for information systems of the type we are discussing. In both cases "extra mailing time" may have to be added.

## Publication Date and the Measurement of Actuality

For the measurement of actuality we are given a coupling between "clock time" and "process time" in the publication date. With knowledge of the size of the "process times" which can be empirically studied, it seems that we can get a good and comparable measure of the actuality of the material in the document. This is so if we know for certain that we receive the document without any undue delay, and when the publication date corresponds to the date of reception. In practice, however, this is not always the case; "only a fraction of the world's scientific journals appear 'on time'" (Garfield, 1972). The discrepancy might be so big that a September issue may be published in January!

This means that the measurement of actuality is quite unreliable.

## Abstracting and Indexing Services

The number of individual subscribers to secondary publications is comparatively very low. It is mostly libraries and information centers that subscribe to these publications and in this study we shall consider abstracting and indexing services as pre-processing for the information system. The close coupling between these secondary information services and SDI-services should be noted: the development of SDI-services mainly due to the fact that much information (references) was becoming available in machine readable form as a result of automation of the abstracting services.

Thus to an information system the abstracting and indexing represents an added delay that affects "actuality$_{IN}$".

The time required for abstracting and indexing is highly dependant on the scheme used by the service. A more complex indexing scheme takes longer. The fastest alternative would be abstracting by underscoring in the original article (if there is no original abstract) and no indexing. This makes it necessary for the SDI-service to develop tools for free-text searching, and possibly more time has to be spent on the formulation of queries. The trade-offs involved are complex and involve a number of different institutions that are geographically, organizationally and sometimes philosophically separated. Evaluation of these trade-offs is a question of general policy. No attempt to such an evaluation will be made here.

We shall leave the abstracting and indexing services as a black box, and note that they represent a delay in the flow of information. The following three figures (19-21) show examples of the size and variance of this delay. The calculations have been made by Malin Edström at the Royal Institute of Technology, Library, Stockholm, from material acquired at the SDI service at RIT. The diagrams show the time a certain journal issue appears for the first time in the SDI output from different data bases.

If we assume that the different data bases have the same processing time in the SDI system the diagrams show the difference in "actuality$_{REG}$" for the data bases. When interpreting the diagrams the periodicity of the data bases must be considered:

ISI-tapes (Institute for Scientific Information) - weekly
INSPEC - biweekly
MA (Metals Abstract) - monthly

The longer the period the more distinct is the stepwise character of the curve. We are aware that the material is small, but it can give some indications of the size and variation of the delays in this process.

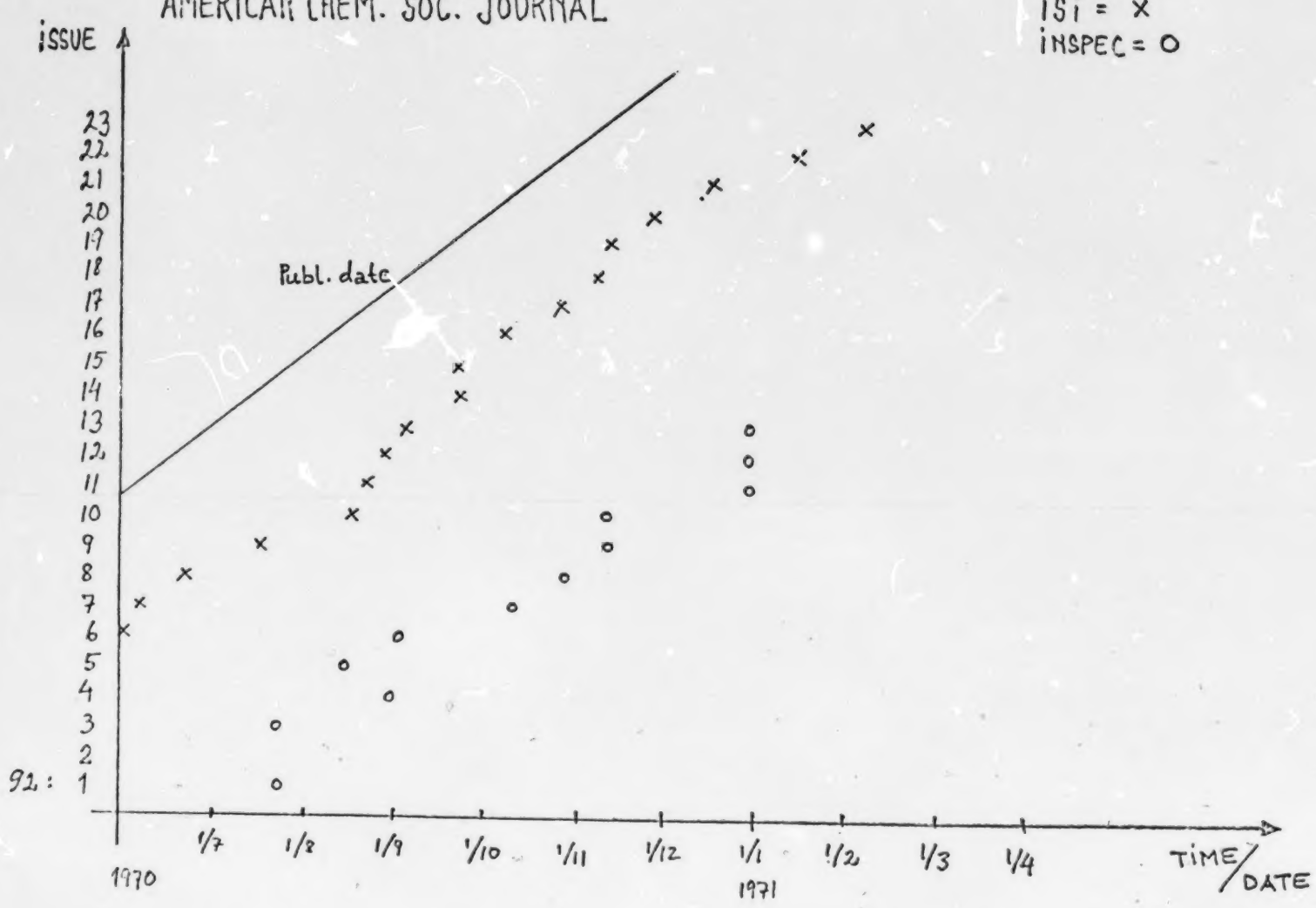



Figure 19.



M. EDSTRÖM

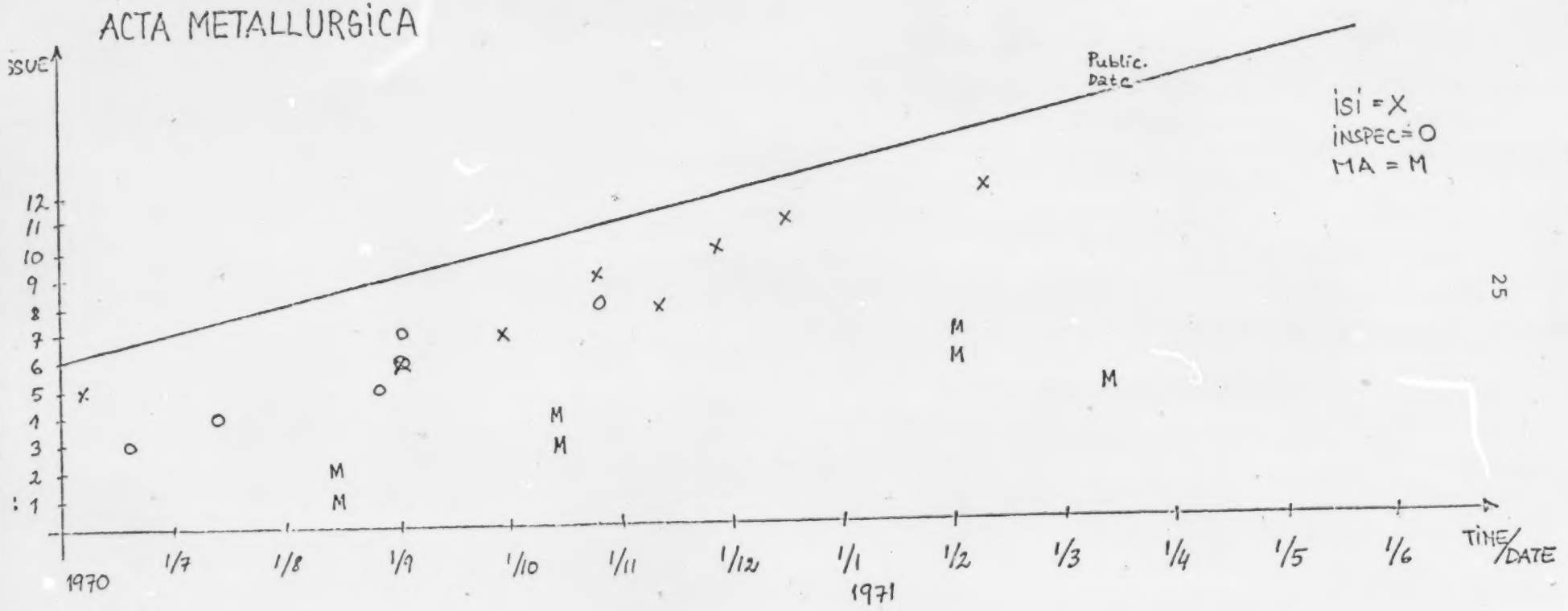

ACTA METALLURSICA
ISSUE
Public. Date
ISI = X
INSPEC = O
MA = M
12
11
10
9
8
7
6
5
4
3
2
1
M
M
M
M
M
M
TIME/DATE
1970
1/7
1/8
1/9
1/10
1/11
1/12
1/1
1971
1/2
1/3
1/4
1/5
1/6

Figure 20.

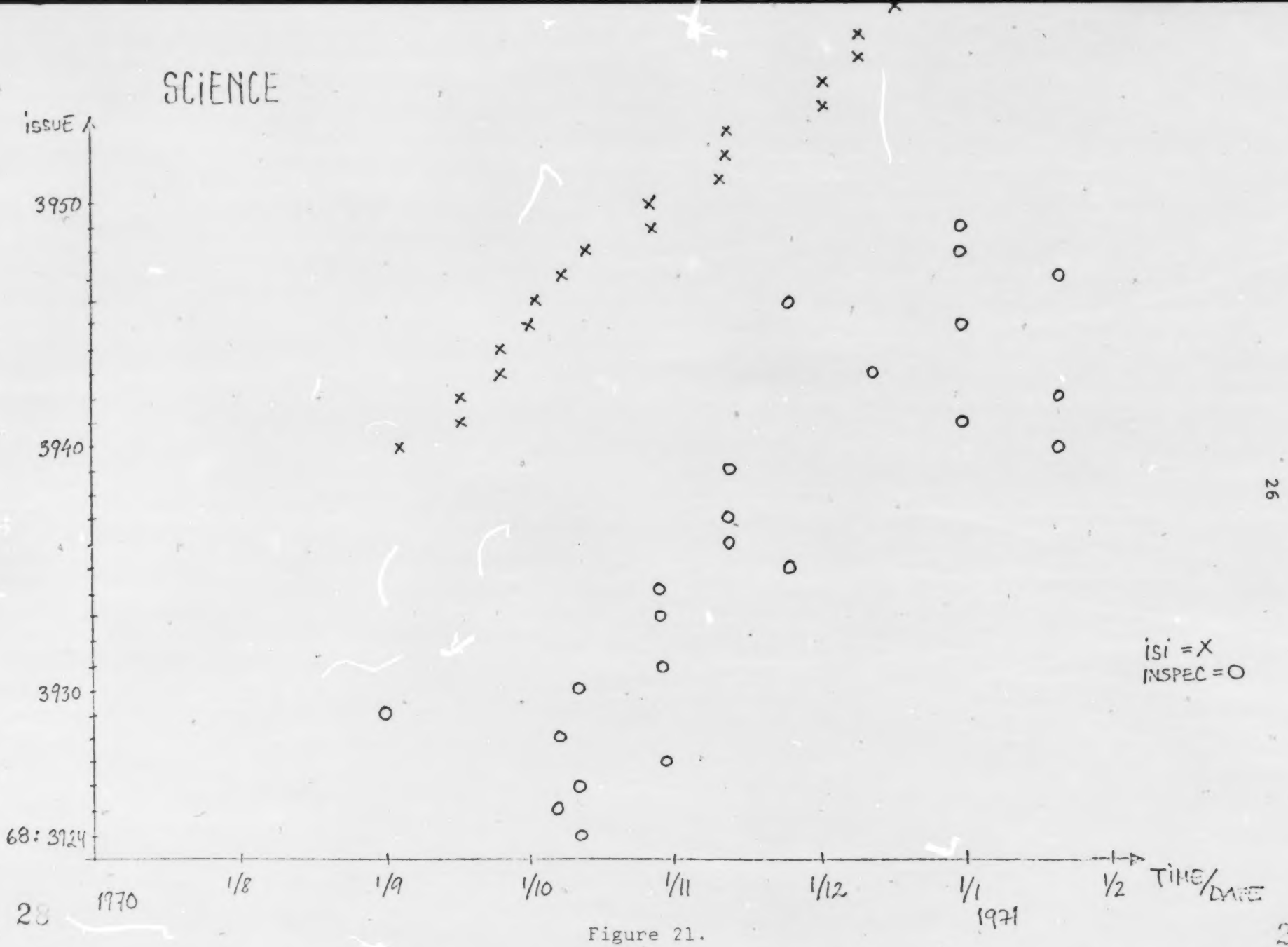

SCIENCE
ISSUE
3950
3940
3930
68: 3924
1970
1/8
1/9
1/10
1/11
1/12
1/1
1971
1/2
TIME/DATE
ISI = X
INSPEC = O

Figure 21.

Libraries: Acquisition and Storage

The acquisition and storage subsystem as we define it takes a document as it enters the information system and puts it into a searchable file.

For journals and certain series of books there are standing orders (subscriptions) which means that there is no lead time for ordering. For books that are ordered individually there is such a lead time and it is composed of two mailing times and the vendors processing time. By establishing routines for the ordering process and agreements with vendors this process can be speeded up. Systems for "Library Automation" can also have a positive effect in this respect.

The principal time factors for this subsystem are shown in Figure 22.

Cataloguing time. The delay from cataloguing is very often significant, in many libraries the cataloguing process is the worst bottle-neck. The problem has many causes such as complex cataloguing rules, too little staff etc. One of the more important savings from library automation would be speedier cataloguing. An interesting alternative was discussed at a US university library (David, 1972). Received, but not yet catalogued, books could be made searchable to the user from a computer terminal and thus allow him to browse in the "in process file". Books that were never asked for could be left in this file (maybe forever!) without being withheld from a user that wanted it.

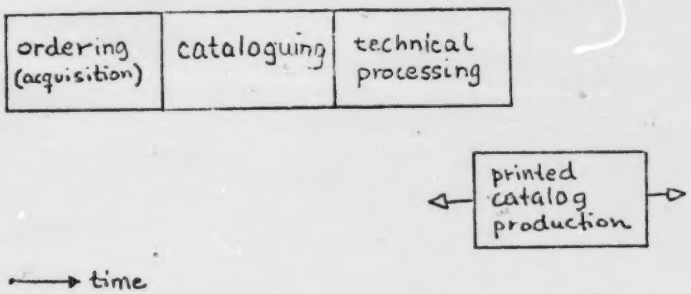

ordering (acquisition)
cataloguing
technical processing
printed catalog production
time

Figure 22.

Technical processing time. In some libraries incoming paperbacks are bound before they are put on the shelf. This and other technical processing, of course, adds a delay before the item is searchable.

Printed catalogue production. Libraries, as a rule, have agreements with other libraries regarding inter-library loans. Before a document is searchable in such a library system (or compound library) the other members of the system must have access to a union catalogue (that may consist of separate volumes for each library). The production of this catalogue can be made parallel to the in-house cataloguing but sometimes there is a considerable delay in this process - partly this delay is due to the fact that a printed catalogue is produced periodically whereas in-house cataloguing is a continuous process. On-line systems connecting different libraries do away with this delay.

Several projects have been carried out to make the library operations more effective, and systems analysis of libraries have been used to improve the design of the processes. Since these studies are made from the library's point of view they do not aim at minimization of the process time although increased "actuality$_{REG}$" is one goal component.

SDI-services: Acquisition and Storage

In some cases an SDI-service processes databases from only one supplier. The bigger SDI-services, however, subscribe to databases from a number of different sources. Sometimes the subscriptions are subject to restrictions as to the discipline covered, e.g. technology, sometimes it is left to the SDI-service to decide what disciplines to include.

The primary source for input material for an SDI-service is the external abstracting and indexing services and sometimes SDI-services have their own in-house production of databases, i.e. "abstracting and indexing". For this study there is no conceptual difference between an in-house produced and externally bought database but we note that the former has no "extra mailing time". This extra delay can be quite significant and experience shows that the distribution systems are very unreliable. Technical errors are frequent and tapes are rejected and replacements have to be ordered.

The situation with databases from different sources present a problem to the SDI-service since there is no practiced standardization for the record format. (There is, however, an ISO-recommendation for a standard format for information interchange.) This means that the SDI-service must make some kind of conversion to an internal processing format - the alternative with different search programs is usually more expensive. The time delay for the conversion varies depending on the structure of the processing format.

To shorten the conversion delay a "mapping approach" could be successful. This means that instead of reading an rewriting each record, the search-program has a number of mapping routines that creates a map (or list of pointers)

for each database. This approach works well for databases that have variable-length records with some kind of directory. For fixed-length records ("card images") the approach imposes new difficulties.

Once the database is in processing format it is, by definition, searchable.

## Retrospective Search Services: Acquisition and Storage

Whereas an SDI-service usually is computer-based a Retrospective Search Service may or may not be.

In the case with computer-based RSS the delays affecting "actuality$_{REG}$" are approximately the same as for an SDI-service with the difference that in an RSS a master-file (of documents) must be updated before the information is searchable.

Since the volume of the master file in an RSS is continuously growing the serial-search approach is normally not feasible. This means that some kind of index file (or inverted file) must be created as part of the updating.

In a combined computer-based SDI/RSS system the two functions can be integrated so that conversion overhead can be shared.

The non-automated RSS (or the non-automated part of a mixed service) resembles a library. The main difference is that catalogues and other tools are designed for the personnel instead of a general public. This could give shorter delays in the cataloguing procedure (or equivalent) partly because the tools will not have to be capsuled in such a rigid (physical) security system, but also because the staff could be allowed to use intermediate catalogues

(i.e. search on in-process material). There is also another possible effect: In an RSS that is specialized there might be needed a very complex and detailed cataloguing scheme, that would be more time consuming than the production of a relatively coarse catalogue for a general public.

Mostly an RSS buys catalogues and search tools from external sources such as abstracting and indexing services, they also rely on libraries to provide the original documents to the user - at least for the present with practically no automated full-text systems operational.

## QUERIES FROM PERCEIVED TO FILLED INFORMATION NEED

### Timeliness and the User

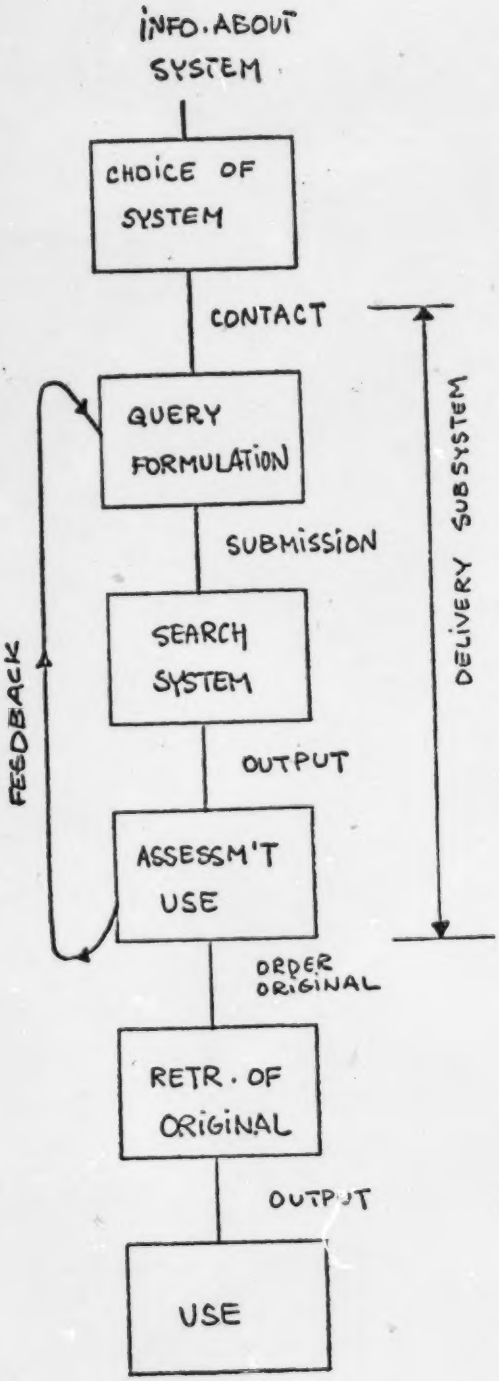
Up till now we have followed a document's way through various channels up to the point it is made searchable in a file. All the delays in the "chains" we have discussed have a direct effect on the "$actuality_{REG}$" i.e. a measure of how fresh the information in a system is. This actuality is one of the timeliness aspects visible to the user, and his evaluation of it may well influence his choice of information system. Thus it is an important parameter for the management of the information system.

Of course the user's primary interest is in "$actuality_{USE}$" but this parameter can be assessed from "$actuality_{REG}$" together with knowledge of the system response time.

Response time is in itself a critical parameter (i.e. not only as a component in assessing "$actuality_{USE}$"): For one thing the user may be irritated by a long response time, but there is also the possibility that the information is needed at a specific "clock time". Miller (1968) gives a good discussion of different situations of man-computer interaction and the psychological aspects of response time.

In very large networks covering different time-zones the correspondence between the system "clock time" at delivery and the user's local "clock time" is a matter of timeliness (although closely related to convenience).

On the below pages we shall follow the way of a query through different information systems and analyze the different aspects of timeliness given above. The framework for the discussion is given in figure 23.




The process of getting and evaluating information about different information systems can best be approached as a study of "motivation".

Feedback in an actual sense is applicable only to SDI-services but the accumulation of knowledge about how to use the information system is valuable in all situations except for the "once-only" - customers.

A common arrangement is that a library provides the original material referred to in SDI-output. In this case the query is passing through another information system before the user can "consume" the answer. This is not the case if the SDI-service provides the full text.

Figure 23.

General Aspects on the Delivery Subsystem

As can be read out from figure 23 the delivery subsystem also includes the communication between the user and the information service. The delivery subsystem accepts an unspecified query (i.e. a query expressed in the user's language) and delivers a document or a reference to the user. Logically this system is composed of three subsystems, and the timeliness parameter is connected to many other parameters in these subsystems:

1. The query input system. Here timeliness is closely related to availability, accessibility, convenience and serviceability.

2. The search system. As elsewhere timeliness is dependant on the system reliability.

3. The output system. Timeliness closely related to serviceability, accessibility, and convenience.

It should be noted that when we follow a query through the system it is more natural to consider the search system to be a subsystem to the delivery system. This partitioning is only one of many possible, but we find it useful for evaluation purposes.

## Libraries: Delivery Subsystem

### 1. Query input

The usual way to transform a request from user's language to a specific query (that gives access to the master file) in a library is to use the card catalogue. If the user has previous knowledge as to author or title this is usually a quick operation. Should he have to look in the subject catalogue there might be a delay depending on his familiarity with the cataloguing scheme used. In most libraries there is a helpful librarian who can shorten this delay.

On-line systems for library automation can help to speed up the "query formulation" process considerably.

If a user is interested in a journal article there is usually no way to find the reference in the regular card catalogue. Instead the user will have to rely on abstract publications that are held by the library, and then find the shelf mark of the journal in the card catalogue.

### 2. Search

The time to fetch a document and prepare it for output, i.e. have it at the desk ready to give to the user, is dependant on the risk of having the book borrowed by someone else, the structure of inter-library loan procedures and other factors. Experiments to speed up interlibrary loans by WATS (Wide Area Telephone Service) in North Carolina (Shuman, 1969) indicates one possibility, For "small" documents facsimile transmission could add more to the increase in timeliness. For extensive documents picture-phone applications are feasible (Samuelson et.al., 1972).

Usually the age of the document will affect search time since older documents are kept in files with longer access time (e.g. repositories, basements or "cold storage" buildings.

3. Output

Normally the output is immediately given to the user, but in case of non-personal order the document can be mailed to him which would add to the delay.

SDI-Services: Delivery Subsystem

1. Query input

Unless the user is experienced in using the particular search system the query input process must begin with a learning period for him. Depending on the complexity of the search language and the assistance given by the documentalists (or other intermediaries) this period may vary from a few minutes to a couple of hours. In an SDI-service it is not necessary to make the user an expert on query formulation at once; he can learn over a longer period of time guided by the results he receives from the service. This is indicated in figure 23 as "feedback".

The query formulation itself is in fact a translation of the query from the user's language (natural language) into a search language (made up of descriptors of some kind and usually a logical structure between them).

Both the learning time and the time for query formulation can be speeded up by the development of good tools such as synonym dictionaries and standardized sub-queries

(usually of a general character so that they can be included in several queries). By incorporating these tools in an on-line system for query formulation still better results could be achieved.

## 2. Search

The automated search process although sometimes very costly is not so important for timeliness. What is more important is the (average) waiting time before the query is processed. Normally a document file is searched as soon as it is searchable, and depending on how frequent the database is issued the search program is run once a month, twice a month etc. Thus a query that is entered into the system in the middle of a cycle must wait for the next run.

## 3. Output

Before the user can "consume" the output it has to be sent to him, but this may not be the only delay: He may need to have the output post-processed. If the output is on michrofiche he must either get a reader or have the document reprinted, if it is on magnetic tape he must have it listed. Sometimes he may have to resubmit his query (in form of a specific reference) to another system, e.g. a library, before his information need is satisfied.

## Retrospective Search Services: Delivery Subsystem

### 1. Query input

For an RSS the time delays in the query input system are about the same as for an SDI-service. It should be stressed, however, that the learning time for the user must be shorter in an RSS since all the adjustments must be done before the query is submitted to search - a retrospective search query by nature is a one time query. Here, as was the case with SDI-services, the query formulation can be speeded up with an on-line system, especially if this system has the facility of allowing test searches on a representative sample of the data-base.

### 2. Search

While an SDI-service processes the documents as they flow through the system an RSS accumulates them. Consequently an RSS will have storage problems sooner or later. It will be necessary to do some accessibility-degradation, and the storage policy applied can be more or less sophisticated; the age of the document could be the criterion for media allocation but the allocation could also be based on careful analysis of usage statistics (supposing that such statistics is collected).

Apart from this question an RSS is similar to an SDI-service.

### 3. Output

As far as output is concerned an RSS service is comparable to an SDI-service.

Some Considerations on Response Time

A transition of an ISS or SDI-system to on-line mode may seem very appealing, and admittedly such a transition has its advantages; faster response time, integration of functions and increased system accessibility at user locations are some of the objectives. From the management point of view such a transition means a more expensive system, and the increase in cost must be balanced against the increase in serviceability (and related parameters).

Although an on-line system probably would give shorter response time this is not the most important benefit. An on-line system makes it possible to include sophisticated service functions and make them directly available to the user. These service aspects should guide the system design, not minimization of response time.

In the case of on-line systems for communications, search, and delivery there are some special characteristics of man-machine interaction that has been taken into account: The user's experience of "waiting time" and "interaction time" is very different - i.e. the user should not be kept waiting for too long a time. Many interactive systems give the user some indication as to what is happening during the processing, for example the system might write messages of the type " x x x x documents have now been searched and we have found y references for you" at suitable intervals during a lengthy search. Miller (1968) gives more examples.

The close and frequent interaction between the user and the system with immediate feedback has traditionally been considered as something good. A recent RAND study shows, however, that an interactive system could be improved by introducing lockouts in the "conversation" (Seven; et al., 1971). With this set-up the user is not pushed to answer the system immediately but takes time to think before "talking".

A lockout time of 5 minutes gave better results in the test situation, but 8 minutes caused disturbance particularly to experienced users.

## OUTPUT CONSUMING SYSTEM

Output consumption closes the circle in our study since it is the system that accepts documents as inputs and produces new knowledge as output. This new knowledge is already in the Document production system of the next cycle.

The time delays in this system are the objects for studies in science theory and psychology, and we shall make no further attempts to analyze them.

## CONCLUSIONS about TIMELINESS

In the above text we have studied timeliness of information provided by original source, SDI, and RSS. We have analyzed the different aspects of timeliness as experienced by the user, and we have identified the delays in the information transfer network.

We have not discussed the problems measurement except for actuality; this problem is not an easy one, the main difficulty being the development of methods that would give an audit instrument for time studies. Research is being carried out in this area and some results have already been reported (Wilkin, et al., 1972). This problematic state of affairs is a consequence of the fact that libraries and information services traditionally have been considered "non-profit centers".

Another thing that has not been done in this study is to quantify the trade-offs to be made between time and other resources. We find this a hard problem to tackle from a general viewpoint; the trade-offs depend on the value of information and time, and this in turn is entirely dependant on the use of the information in question.